RESEARCH ARTICLE

Crop Switching as Climate Change Adaptation Strategy of Farmers in the Province of Batangas

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Abstract

The geographical scope of the agricultural crops is changing as a result of climate change. In order to reduce the possible negative impacts, notably in developing countries such as the Philippines, this shift requires that crops are switched effectively at community level. In the agricultural communities of the Batangas province, the study identified the social and environmental determinants of crop switching as a locally relevant option for resilience building. One of the key conclusions is that temperature extremes prompted smallholder farmers to abandon crops that cannot tolerate climatic stresses. Introduction of short duration crops and adoption of heat and moisture resistant seed varieties alongside implementation of community-based approaches are suggested to curtail the adverse impacts of climate risks.

Keywords: crop switching, climate risk resilience, smallholder farming, Batangas

I. Introduction

In the past few years, climate change and its impacts have become more evident, especially regarding extreme weather events and disasters. As a result of the uncertainties and risks resulting from climate change, developing countries like the Philippines have also become more vulnerable. In light of the Intergovernmental Panel on Climate Change (IPCC) Fifth Assessment Report, many adaptation options can help address climate change, but no single option is sufficient by itself. Effective implementation depends on policies and cooperation at all scales and can be enhanced through integrated responses that link adaptation with other societal objectives. (IPCC, 2014).

In the context of climate change, people's creative genius and adaptability are well recognized. For centuries, at a variety of spatial and temporal dimensions, human beings adapted to the changing climate around them. It's incorporated into man's systems, which take account of the climate as it is. In particular at the local level, climate variability affects peoples' choices with consequences for their social, economic, political and personal circumstances as well as impact on their lives and livelihoods. The ability of people to survive through mainly autonomous coping mechanisms and survival strategies is provided by constant challenges in human well being.

The climate change literature generally defines adaptation as changes to the system in response to climatic stimuli.To effectively manage the risk of climate change, it is essential to implement strategies for both mitigation and adaptation. However, a line does not necessarily need to be drawn between vulnerability reduction interventions (e.g. livelihood diversification, literacy promotion and capacity-building activities) and impacts-targeted measures when they can be seen in a continuum of approaches. In this way, a wide range of development issues, such as actions to reduce poverty and build capacity to address risks and climate change impacts, may be covered by adaptation efforts.

In recent years, due to the individual actions of communities and the need to

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mainstream climate change adaptation into the development process, local adaptation activities have received a lot of attention. Adaptation at the local level is about strengthening communities by building on their own strategies to cope with climate change, enabling them to engage in policy development related to climate change. Adaptation at the local level is about strengthening communities, building on their own adaptation strategies to cope with climate change and empowering them to participate in the development of climate change policies (Reid et al., 2007). The adaptation is specific to the particular location and therefore local actors are of crucial importance for achieving a real impact on the ground. For example, the local government has a key role to play in creating an enabling environment for adaptation. As far as policy is concerned, rapid adaptation actions can be helped by the support of local governments. The capacity of actors to take action, data available at local level and funding support for adaptation initiatives (McGray et al., 2007; IFRC and the ProVention Consortium, 2009), are key factors that contribute significantly towards achieving a significant degree of impact.

From national to community level, decisions on adaptation strategies and measures are taken, Carter and Raps, 2008. Action and commitment of national governments to the preparation of policies and strategies for dealing with climate change have been increased in view of the urgency of this issue. However, few strategies have been developed at national level that take into account the local context or are tailored to the different local scenarios. There is often a lack of coherence in the national and provincial frameworks as well as at village level policy. During the planning and development of adaptation strategies, there is a lack of awareness about the importance of regional context. This means that efforts to adapt fail to achieve a real impact on the ground.

This study identifies socio-economic and environmental determinants to adopt crop switching as a locally relevant resilience-building option in agricultural communities in the province of Batangas, particularly in Barangay Halang in Lipa City. This also analyzes the vulnerability of these communities and assess impacts of hazards directly from the point of view of those affected themselves.

This paper provides an answer to the question 'What are the socio-economic and environmental determinants to adopt crop switching as a locally relevant resilience-building option in agricultural communities in the province of Batangas particularly in Brgy. Halang, Lipa City?'. This also analyzes the vulnerability of these communities and assesses impacts of hazards directly from the point of view of those affected themselves. Specifically, this determines the crops that have been either adopted or abandoned by the farmers over the past 20 years. Also, this identifies the drivers to either adopt or abandon the crops.

In Batangas farming communities, we conducted a comprehensive assessment of crop transformation as a climate change adaptation strategy. Crop Switching is expected to significantly reduce climate-related agricultural damage, particularly among small farmers, informing local government adaptation planning.

This study builds on the works of Tessema et al. (2019), Alauddin and Sarker (2014), and Mertz et al. (2009) to identify the specific types of crop switching decisions induced by climate change and their determinants. Crop switching decisions were examined specific to the level of individual crops with the aim of identifying the determinants of the specific crop switching decisions primarily motivated by climate change. The examination of crop switching in detail at the level of individual crops enabled us to validate the results based on predictions from studies on crop distribution modeling and ecological change. This will be a key addition to the literature on farm-level adaptations in general where the link between climate change and farm adjustments is still unclear. The identification of the socio-economic and environmental determinants of crop switching is also vital to suggest interventions that could keep adjustment costs as minimal as possible.

The Philippines agricultural sector, which contributes around 12% of the country's Gross Domestic Product (FAO 2017), employs about 32% of its population with an economic activity. The lack of infrastructure, as well as political and institutional obstacles to the sector's ability to meet food demands due to an increasing population has resulted in a combination of agricultural characteristics such as small scale but fragmented farms that are difficult to cope with. This has resulted in a heavy reliance on food imports, especially wheat and rice, the population’s main staple crops (FAO, 2017).

1.1. *Agriculture and Climate Change*

A relatively hot climate with high humidity and abundant rainfall prevails in the Philippines. The warmest month of the year shall be January with a mean temperature of 25.5 C, while May's is 28.9 C. However, changes in altitude lead to significant variation in temperature throughout the country and mean annual temperatures are 26.6 C. In Baguio, a high mountain town in the north of Luzon, for instance, temperatures are more closely related to mild temperate areas. The country has a high relative humidity, ranging from 71% in March to 85% in September. The mean annual rainfall ranges from 965 to 4,064 mm. The most rainfall will come from Baguio City, East Samar and Eastern Surigao while South Cotabato receives the least. The Philippines has two major seasons: the dry season which runs from December through May, and the wet season that runs from June to November. Between 1951 and 2010, the country experienced an increase in its average temperature of 0.64C. According to climatic projections of the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA), all areas of the country are expected to get warmer in the short- (2020) and medium term (2050). A reduction in rainfall is also projected during the months of March, April, and May.

The Philippines is one of the countries that are vulnerable to climate change because of its geographic location and archipelagic structure. This country is the world's most vulnerable to tropical cyclones, with the highest exposure of people to these events, and it's among the most affected by extreme weather events. Furthermore, the agriculture sector has experienced an annual high proportion of damage due to disasters, which are primarily caused by climate change. Typhoons, droughts, and floods accounted for 70%, 18%, and 5%, respectively, of the damage to agricultural production from 1990 to 2006. According to estimates, the industry is expected to incur a total of US$ 136 million annually due to typhoon damage. Recent studies have indicated that, in general, the Philippines economy could be hit with about US$505 million a year by 2050 due to climate change. Climate change and variability are expected to reduce yields of crops, increase the occurrence of pests and diseases and cause shifts in crop production suitability as a result of increased water and heat stress. By providing suitable conditions for the emergence of new crops, upland areas could thus benefit from an increase in temperature.

1.2. Response Options for Adaptation and Mitigation

Burton et al. (1978) propose a society based classification of adaptation and adaptation to natural hazards on the basis of people's perception of nature's threat in a landmark book, "The Environment as a hazard". Unconscious biological and cultural adaptations are distinguished from accidental or intentional changes in this classification. Traditional societies have been accused of being incapable of facing natural hazards and are compared with industrial Western societies whose adjustment has proven more efficient but still not perfect. Institutions such as National Governments, International Organizations, and consultant agencies involved in the management of volcano hazards and disasters have also been experiencing a paradigm shift towards perception adjustment. In the face of volcanic threats and inadequate behavioral response, structural and technical solutions (e.g. sabo dams and dikes to control lahars, electronic devices to closely monitor the activity of the volcano, hazard mapping) are preferred along with evacuation plans and information campaigns to raise people's perception of hazardous phenomena. At the beginning of the 1990s International Decade for Natural Disaster Reduction, influence and recommendations derived from a perception adjustment paradigm can be seen. During that period, when it was argued that volcanic eruptions did not cause too much damage to developing countries which bore the brunt of volcanoes' havoc (Benblidia 1989, Lechat 1990), the United Nations pushed for an increased financial, technical and experience transfer from industrialized countries.

Drawing on cases from the economically developing world, scholars such as O'Keefe et al. (1976), Hewitt (1983), Wisner et al. (2004) argue that the social, economic and political forces beyond their control constrain people's behavior when faced with natural hazards. Unpowerful persons living in areas of danger without adequate physical or social protection are being forced to do so by political neglect, social marginalization and lack of access to resources. This view stresses the vulnerability of people and their susceptibility to damage in the event of natural disasters. The vulnerabilities of disaster victims are reflected in the set of indicators. Victims of natural hazards are frequently disproportionately drawn from marginal social groups such as women, children, elderly and the disabled. The vulnerable also include people with limited or precarious income, who are less able to protect themselves against natural hazards due to insufficient wages, informal employment, lack of savings that reduces their ability to take protective action on the basis of home location, types of housing and knowledge of protection measures. The lack of social protection, such as medical insurance, health services, building rules, prevention measures etc., and limited social capital solidarity networks are also contributing to vulnerability. In the light of these facts, it is therefore essential to take a critical look at both people's vulnerabilities and their root causes which are found in everyday and unique local contexts (Chester 1993, Wisner 1993). Then instead of being an extreme and rare phenomenon, the natural hazards can be regarded as a source of illumination or amplifier for daily suffering and everyday emergencies (Hewitt, 1983, Maskrey, 1989).

In principle, social, political and economic factors, such as poverty reduction, fair access to land and resources, better social protection through government investment in social services, are recommendations to mitigate people's vulnerability in the face of natural hazards. Specific risk management measures are viewed through community-based disaster risk management which underlines people's participation in hazard, vulnerability and risk assessment (e.g. Anderson and Woodrow, 1989, Bankoff et al., 2004). In 1994 at the International Conference on Disasters Reduction Yokohama Japan, UN support was obtained for such activities leading to a change in international disaster management policy.

1.3. Adaptation Strategy in Batangas Province

Meanwhile, in the province of Batangas, the City Veterinary and Agricultural Services (OCVAS) of Batangas City in collaboration with the East West Seed Co. have introduced intercropping methods in the Pinamucan area of the said city. It is this multi cropping practice which involves the production of two or more crops in proximity. This practice may allow farmers to evaluate the suitability of crops. Due to its location and hill terrain, irrigation has been a challenge for the agricultural sector of Pinamucan. Intercropping facilitates the choice and cultivation of crops that yield higher yields, which allows farmers to adjust to their climate conditions so they are able to earn more. In an intercropping farm in Pinamucan, bitter gourds, string beans, eggplants, green chilies, tomatoes and watermelons are among the most productive crops. To allow local farmers to test the best commodity for which they can derive maximum benefit, the City Agriculture Office has also launched a number of new varieties. For all the varieties that are grown together, a single harvest schedule does not exist. The yield is therefore erratic. They weigh the yields after they are harvested so that records of them can be kept. Farmers do not only sell their products in the market, they also consume them to meet their basic needs. It is considered possible that the intercropping approach will be an option to increase agriculture's productivity, which would enable farmers to ensure food security throughout the year. Farmers also collect crop seeds at the same time as harvesting the produce, which are then used for the next round of cultivation. Local farmers are not accustomed to the practice of intercropping. The effort to measure that method's potential for improving crop stability and ensuring food security in comparison with monocropping systems is also supported by this. Local farmers in Pinamucan have been appreciative of the use of intercropping. It's a way for them to make money, and many also involve members of their families in the farming activities. This climate resilient cropping practice has brought smiles to many faces.

1.4. *Crop Switching as an Adaptation Strategy*

According to global modelling studies analyzed by Costinot et al. in 2016, an effective crop switch can prevent a third of the potential damage from climate change on agricultural production. In this context, we shall consider crop switching to include two types of changes: the initiation of a new crop for the first time; and the abandonment of existing crops. Thus, as opposed to farm level, the term switching is more easily understood at plot level; i.e. planting a new crop does not necessarily mean that it abandons current crops or vice versa.

Studies of crop switching as adaptation response and factors facilitating it have been carried out in the past. The majority of these studies sought to discover whether farmers were adapting by changing crops and what type of socioeconomic or environmental factors affected this process (Maddison et al., 2007; Deressa et al., 2011 Gbetibouo, 2009;

Bryan et al., 2013). These studies do not attempt to separate from each other the different types of adaptation decisions which are primarily driven by climate change, but consider crop changes only as one type of adaptation response. According to the literature, this is a major gap since some types of switching decisions might be driven by non climatic drivers like priceSeo and Mendelsohn, 2008, amongst others. The relevant focus in the preceding studies was not placed on non climatic variables (Below et al., 2012; Fosu-hanMensah et al., 2010; Gbetibouo et al., 2010). However, the shift in crop composition is driven by a range of factors such as market dynamics, pest incidence and soil degradation. Therefore, it is essential to take account of these drivers so as to gain a good understanding of the actual importance of climate change in changing crops.

II. Data and Methodology

2.1. *Study Area*

Barangay Halang is a part of Lipa City in the province of Batangas. It is located at the northwest end of the city and is the only barangay of Lipa that has access to Taal lake. With an area of 280.596 hectares, Halang is divided into six administrative units or puroks. The divisions seem to be more related to the minimum basic needs program of the central government planning office than to administrative reasons. However, such division is very useful to assess the barangay.

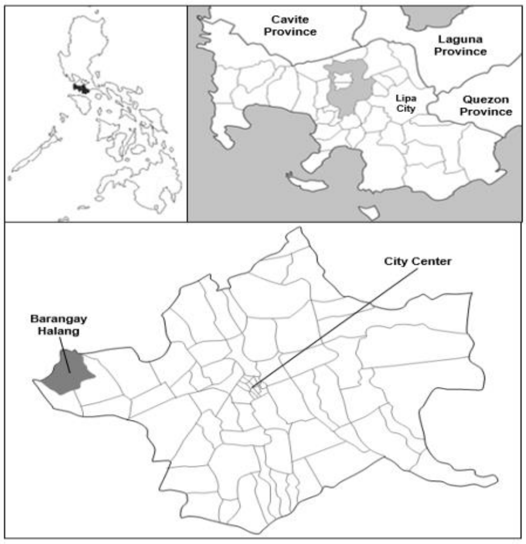

Fig. 1. Location map of Barangay Halang in Lipa City, Batangas province, and country

The upland area is composed of purok 1, 2, 3, and 4. Purok 5and 6 in fact are considered to be one unit and named "sitio Tagbakin" since they form a residential area and are geographically distant from the rest of the barangay. Households are on both sides of the main road that passes through the middle of the barangay from south to north down to the Taal lake coast. This road leads to a freeway that eventually leads to Lipa's downtown. In fact, from the gates of the barangay to the freeway this road also goes through another two barangays. The first four puroks are located at the sides of this main road from the entrance until mid-way to the lake, while the rest of the journey has no households. Once the main road reaches the coast, it turns left, following the shores of the lake. Beside this coastal road is where sitio Tagbakin is located. The road ends at a rock elevation where there are also some houses.

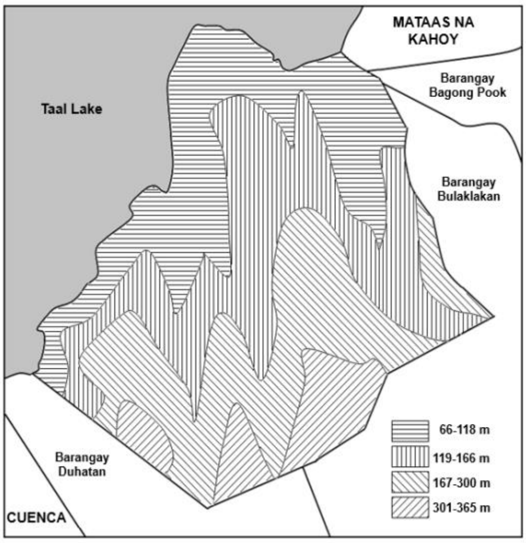

Fig. 2. Topographic Map of Barangay Halang

Farming is one of the principal income generating activities in the barangay, and covers the biggest area in the system. Many benefit from coconut raising; many people are farmers. Halang has rich natural resources for farming. Farm products include coconut, coffee, lanzones, and vegetables.

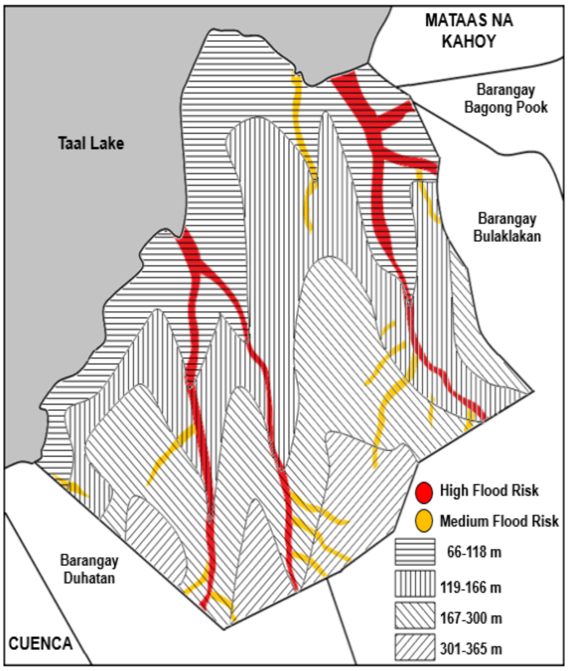

Fig. 3. Flood hazard map of Barangay Halang

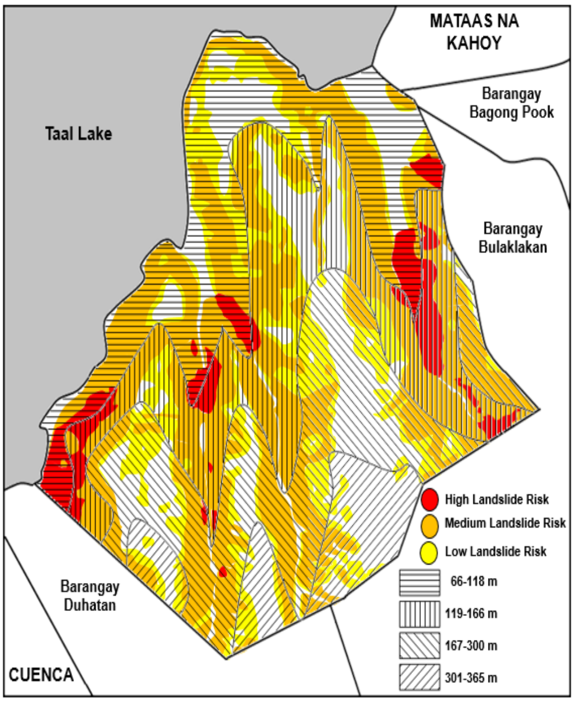

Fig. 4. Landslide hazard map of Barangay Halang

1.2. *Data Collection*

The types of crops that farmers have been permanently adopting or abandoning for the last 20 years are a first key issue that was examined. For each of these crop switching decisions, respondents were asked through focus group discussion to identify the first and second most important drivers from a list of potential drivers: climate change, pest and disease, price change, soil erosion and changes in intra household characteristics. Respondents were also given the opportunity to mention other drivers in case the list is not exhaustive enough for them through the discussion which was being conducted.

1.3. *Ethical Considerations of the Study*

The research project was conducted with full respect of the ethical standards in this field. The research started with a focus group discussion with farmers in Brgy. Halang in Lipa City and involved human participants.. The researcher takes on the primary responsibility of clarifying clearly what research is about to its participants. A one page "project information document," describing the study's objective, who is financing and carrying out the study, as well as its dissemination and use, was provided to each research participant.

III. Findings and Analysis

This section reports the findings of the study based upon the information gathered. The findings are particularly relevant for adapting crop switching as a climate change adaptation strategy in the context of smallholder agriculture in the province of Batangas.

Coconut, banana, gabi, ube, calamansi, and citrus are the crops that have been adopted by the farmers over the past 20 years in Brgy. Halang in Lipa City. Although planting is still manual using a hoe, these crops need minimal care. These crops come back every year without replanting and there is no need to rush each spring to prepare the soil to plant between rains. This is a huge benefit to farmers who want to avoid the trap of over-work and micro-management.

Coffee, cacao, rice, corn, pepper, lanzones, luya are the crops that have been abandoned by the farmers over the past 20 years. Climate change, crop diseases, low price, pest, and household changes were the reasons why the farmers no longer plant these crops. For instance, coffee farming means living an uncertain life with a great deal of difficulties in producing the beans. Although there are measures that may improve quality and thus prices, market trends and harvest yields and quality reported by the farmers are not predictable. Nothing is certain until the local entrepreneurs bag, cup, and sell the coffee. The coffee industry is lucrative, but it's notoriously underpaid to producers. The increasing temperatures and changing precipitation patterns are currently a result of climate change.

The land available for coffee cultivation has decreased as the climate changes. In fact, an Intergovernmental Panel on Climate Change Forecasts a 10 to 20% drop in total crop yields by 2050. The fact that climate change is spreading pests and threatening plants and crops must also be borne in mind.

In the 2018 Observed Climate Trends and Projected Climate Change in the Philippines report by the Department of Science and Technology and the Philippine Atmospheric, Geophysical and Astronomical Services Administration (DOST-PAGASA), it suggests a wide range of future changes in Philippine rainfall. In many areas, especially in Mindanao, by the end of the 21st century, the driest possible change in rainfall could exceed 40%. The wettest possible change, on the other hand, could exceed a 40% increase in rainfall, particularly over Luzon, western sections of Visayas, and some parts of Mindanao. The multi-model central estimate future rainfall conditions will be well within its natural variability; except for the drier future over central sections of Mindanao, particularly in September-October-November and the December-January-February seasons, which might require actionable climate change adaptation plans.

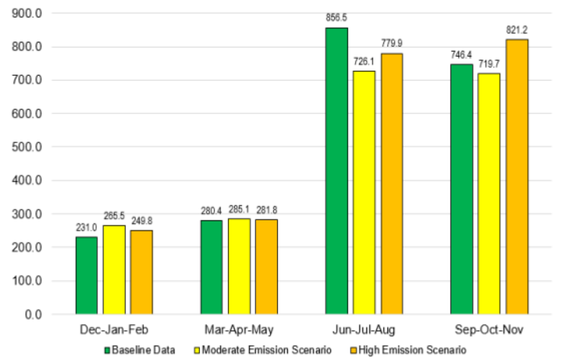

Fig. 5. Climate Information Risk Analysis Matrix (CLIRAM) of the projected seasonal change in total rainfall (in millimeters) in the mid-21st century (2036-2065) for Batangas; baseline period: 1971-2000

Meanwhile, most areas in the country have experienced air temperatures exceeding 26°C, while as expected, slightly cooler areas are found in mountainous regions. These temperatures are projected to increase uniformly and minimally across the country in both the moderate-emission and the high-emission scenarios.

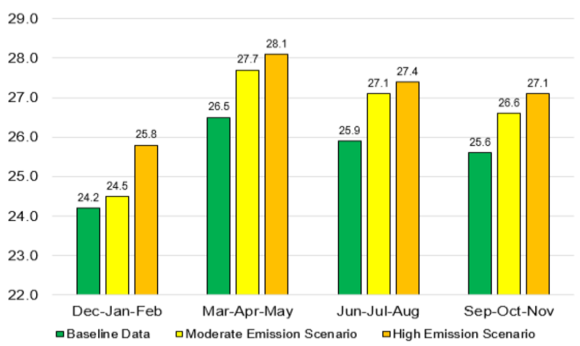

Fig. 6. Climate Information Risk Analysis Matrix (CLIRAM) of the projected seasonal change in mean temperature (in degree Celcius) in the mid-21st century (2036-2065) for Batangas; baseline period: 1971-2000

Given these facts and the existence of climate risks, introduction of short duration crop varieties is likely to contribute to limiting negative effects on climate risk (Lasco et al 2011). Corn, root crops such as sweet potatoes and cassavas, vegetables like asparagus, string beans, cabbage or mushrooms are also cultivated to a shorter duration. Similarly, it is possible to address the problem of insufficient heat or humidity by selecting seed varieties with a warm and moist resistance.

Community-based approaches are suggested to address the challenges. These approaches take into account the inherent adaptability capacities of vulnerable communities, which they aim to build upon. The importance of adaptive capacity in building resilience is that it entails processes and capabilities enabling a continuous response to changing and uncertain climatic conditions over time. When climate vulnerable communities are given greater access to, accumulation and control of assets, knowledge and information, confidence in and access to innovation, access to effective institutions and entitlements, and are able to make more flexible and forward looking decisions, their adaptive capacity is strengthened.

Meanwhile, household changes, particularly aging farmers, is another reason for abandoning farming of the aforementioned crops. In the Philippines, the average age of a farmer is already 57, according to the Department of Agriculture - Agricultural Training Institute (DA-ATI) in 2013. Farming may not be their choice for their children's future, although several farmers have survived the economic and environmental crises of the last decades. The aging farmers toiling on the land since the 1970s and 80s are what Pamela Riney-Kehrberg, professor of history at Iowa State University in the US, calls "last generation" farmers. Maybe they have children and relatives who will inherit the land. But a lot of them haven't had anyone to farm for quite some time.

Respondents of this study are open to new strategies, nevertheless, they have doubts. A farmer's reluctance to take risks, the loss of local knowledge and limited access to agronomical information hinder his ability to adopt diversification strategies. In particular, it is smallholder farmers who stand to benefit from this. Hence, increasing awareness on climate change adaptation at the barangay level may help alongside building the capacity of municipal and local government officials, promoting and increasing multi-stakeholder participation, promoting income diversification, and enhancing coordination between the institutions implementing policies on adaptation to climate change at various levels.

IV. Conclusions and Recommendation

Temperature extremes prompted smallholder farmers to abandon crops that cannot tolerate climatic stresses. Introduction of short duration crops and adoption of heat and moisture resistant seed varieties alongside implementation of community-based approaches were suggested to curtail the adverse impacts of climate risk.

Not only reducing vulnerability to climate change, but also sustainability and livelihood improvements are at the heart of adaptation strategies. How people, especially the vulnerable, are able to sustain their livelihoods and the role of natural resources and external services in their livelihood activities need to be communicated to local adaptation. As a basis for building resilience in towns and cities, the most effective combinations of measures should be used to safeguard and enhance their community asset base and provide better services. Local adaptation strategies, which aim to build resilience for livelihoods, are therefore of crucial importance because they will have a considerable impact on how the Community copes with climate change. Table 1 outlines recommendations and actions to reduce climate change vulnerability and enhance human and social assets in Brgy. Halang.

Recommendation	Specific Action Plan
Increasing awareness on climate change adaptation at the barangay level	The Agriculture Committee of the Lipa City government unit needs to scale up information, education and communication on climate change and to address the gaps in knowledge and information sharing at the barangay level
Building the capacity of municipal and village government officials	Provide Information, Education and Communication and training of barangay officials on climate change
Promoting and increasing multi-stakeholder participation	Develop ties with the academe, NGOs operating in the city and the private sector to encourage collaboration and support in terms of research, funding and facilities
Introducing short duration crop varieties, and adopting heat and moisture resistant seed varieties	Introduce short duration crops as these may help to reduce climate risk's adverse effects; and heat and drought resistant seed varieties, in order to solve the problem of excessive warmth or humidity
Promoting income diversification	Promote agricultural products and explore social enterprises in non-climate-sensitive sectors especially in the lean months
Increasing coordination at different levels of institutions that implement climate change adaptation policies	Introduce insurance mechanisms and other community-based approaches to address climatic risks and challenges

Tab.1. Recommendations and actions to reduce climate change vulnerability and enhance human and social assets in Brgy. Halang

Although there are possibilities of adapting to climate change in agriculture, lack of awareness at the barangay level, lack of support from institutions and financing hinder smallholder farming to face climate variability. Some technical measures together with local knowledge may help initially, however, research related to the magnitude of climate change impacts on specific crops varies among ecological zones. In addition, it relies primarily on the available resources for smallholder farmers to address these challenges. It is very difficult and virtually impossible to draw conclusions from this context regarding the impact of climate change on peasant farming, as well as its consequences. Moreover, there is a limited number of studies that assess the effects of climate conditions on crop yield beyond temperature and thus an area for further research.

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